Dec 10, 2024

Comparison of Dosimetric Characteristics and Treatment Efficiency of VMAT Plans on Halcyon and Infinity Linear Accelerator Platforms for Non-Small Cell Lung Cancer (NSCLC) Radiotherapy

PLOS One

DOI
https://dx.doi.org/10.17504/protocols.io.ewov1dqrkvr2/v1

Kainan Shao[1], Fenglei Du[2], Lingyun Qiu[1], Weijun Chen[1]

[1]Cancer Center, Department of Radiation Oncology, Zhejiang Provincial People's Hospital (Affiliated People's Hospital), Hangzhou Medical College, HangZhou, Zhejiang, China;
[2]Department of Radiation Physics, Zhejiang Cancer Hospital, HangZhou, Zhejiang, China

Kainan Shao
Zhejiang Provincial People's Hospital (Affiliated People's H...

Create & collaborate more with a free account

Edit and publish protocols, collaborate in communities, share insights through comments, and track progress with run records.

Create free account

OPEN ACCESS

DOI: https://dx.doi.org/10.17504/protocols.io.ewov1dqrkvr2/v1

External link: https://doi.org/10.1371/journal.pone.0318462

Protocol Citation: Kainan Shao, Fenglei Du, Lingyun Qiu, Weijun Chen 2024. Comparison of Dosimetric Characteristics and Treatment Efficiency of VMAT Plans on Halcyon and Infinity Linear Accelerator Platforms for Non-Small Cell Lung Cancer (NSCLC) Radiotherapy. **protocols.io** https://dx.doi.org/10.17504/protocols.io.ewov1dqrkvr2/v1

Manuscript citation:
Shao K, Du F, Qiu L, Zhang Y, Li Y, Ding J, Zhan W, Chen W (2025) Comparative analysis of VMAT plans on Halcyon and infinity for lung cancer radiotherapy. PLOS ONE 20(2). doi: 10.1371/journal.pone.0318462

License: This is an open access protocol distributed under the terms of the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited

Protocol status: Working
We use this protocol and it's working

Created: December 09, 2024

Last Modified: December 10, 2024

Protocol Integer ID: 114593

Keywords: Volumetric Modulated Arc Therapy (VMAT), Lung Cancer, Dosimetric Comparison, fractionated radiotherapy, radiotherapy this study, radiotherapy, dosimetric performance, differences in dosimetric characteristic, comparison of dosimetric characteristic, treatment efficiency of vmat plan, regarding dose coverage, dosimetric characteristic, modulated arc therapy, identical dose constraint, dose coverage of the target, significant advantage in treatment efficiency, treatment efficiency, platform selection in clinical practice, arc therapy, treatment plan complexity, infinity linear accelerator platforms for non, infinity linear accelerator platform, treatment plan, nsclc patient, using raystation 9a, dose exposure, dose exposure to organ, treatment time, linear accelerator, halcyon platform, platform selection

Disclaimer

DISCLAIMER – FOR INFORMATIONAL PURPOSES ONLY; USE AT YOUR OWN RISK

The protocol content here is for informational purposes only and does not constitute legal, medical, clinical, or safety advice, or otherwise; content added to **protocols.io** is not peer reviewed and may not have undergone a formal approval of any kind. Information presented in this protocol should not substitute for independent professional judgment, advice, diagnosis, or treatment. Any action you take or refrain from taking using or relying upon the information presented here is strictly at your own risk. You agree that neither the Company nor any of the authors, contributors, administrators, or anyone else associated with **protocols.io**, can be held responsible for your use of the information contained in or linked to this protocol or any of our Sites/Apps and Services.

Abstract

This study aims to evaluate the dosimetric performance and treatment efficiency of two linear accelerators, Halcyon and Infinity, in volumetric modulated arc therapy (VMAT) for non-small cell lung cancer (NSCLC). A retrospective analysis was conducted on treatment plans for 60 NSCLC patients who received conventional fractionated radiotherapy. All plans were optimized using RayStation 9A, with identical dose constraints and optimization parameters to ensure a fair comparison. Key comparisons were made regarding dose coverage of the target (CTV and PTV), dose exposure to organs at risk (OARs), treatment plan complexity (e.g., control points and monitor units (MUs)), and treatment efficiency (treatment time). The results indicate that the Halcyon platform has a significant advantage in treatment efficiency, while the differences in dosimetric characteristics between the two platforms were minimal. This study provides critical data to support platform selection in clinical practice and lays the foundation for future multi-center comparative studies.

Materials

1. **Equipment and Instruments**

Radiotherapy platforms:
Varian Halcyon linear accelerator
Elekta Infinity linear accelerator

Treatment Planning System (TPS):
RayStation 9A (RaySearch Laboratories AB, Stockholm, Sweden)
Used to generate VMAT plans for both the Halcyon and Infinity platforms.
Data storage and analysis systems:

SPSS software: Used for statistical significance analysis.

Files and reports:
RayStation reports containing patient treatment plans.
Treatment time recording data from the Halcyon and Infinity platforms.

2. **Primary Experimental Materials**

Patients: Treatment data from 60 non-small cell lung cancer (NSCLC) patients.
Data collection:
The definitions of CTV and PTV were consistent for all patients, and OARs (lungs, heart, esophagus, and spinal cord) followed the standard radiotherapy protocol.
Treatment plan parameters, dose reports, and treatment times were stored in the research database.

3. **Software and Data Analysis Tools**

RayStation 9A: Used for treatment plan generation.
R programming language: Used for data processing and statistical analysis.
SPSS: Used for statistical significance analysis ($p < 0.05$) and t-tests.

METHODOLOGY

1 Experimental Design Type: Retrospective study Number of patients: 60 patients with non-small cell lung cancer (NSCLC) Treatment method: Conventional fractionated radiotherapy using the VMAT (Volumetric Modulated Arc Therapy) technique Description: Each patient was clinically diagnosed with NSCLC and met the eligibility criteria for radiotherapy. Dual plans were created for each patient on both the Halcyon and Infinity platforms to ensure comparability and consistency in the analysis.

2 Treatment Equipment Radiotherapy platforms: Halcyon linear accelerator Infinity linear accelerator Treatment planning system: RayStation 9A planning system Optimization parameters: To ensure comparability between the two platforms, all plans utilized the same dose constraints and optimization parameters. Plan type: VMAT (Volumetric Modulated Arc Therapy) plans Description: Consistent dosimetric constraints and optimization criteria were adopted between the Halcyon and Infinity platforms to ensure the fairness and reproducibility of the experiment.

3 Interventions and Treatment Protocols Plan design: Treatment plans for Halcyon and Infinity were generated for each patient using the RayStation 9A system. Dosimetric evaluations of the Clinical Target Volume (CTV) and Planning Target Volume (PTV) were performed for each patient. To reduce the bias of dose differences, all patient treatment plans used identical dose constraints and optimization criteria. Dose constraints: Dosimetric parameters for CTV and PTV: D98% (minimum dose to 98% of the target volume) D2% (maximum dose to 2% of the target volume) Dmean (mean dose to the target volume) Dose limits for Organs at Risk (OARs): Dose exposure for the lungs, heart, esophagus, and spinal cord was evaluated. Key evaluation indicators included Dmax, Dmean, V20, and V5 dose-volume metrics.

4 Measurements and Observations Measurement objectives: Target dose coverage: Evaluation of D98%, D2%, and Dmean for CTV and PTV. Normal tissue sparing: Dose exposure for critical organs at risk (OARs) was assessed. Plan complexity: Implementation difficulty was assessed using plan complexity indicators (e.g., number of Monitor Units (MUs) and number of control points). Treatment efficiency: The treatment performance of the Halcyon and Infinity platforms was quantified by monitoring treatment time and treatment process efficiency. Data collection: Dosimetric data were collected using exported report files from the RayStation 9A system. Treatment times for Halcyon and Infinity were recorded, and the difference in treatment time for each patient was compared. Data management and storage: All raw data (dosimetric reports and treatment time data) were stored in the research database. Access to the database was restricted to the principal investigators of the project.

5 Data Analysis Comparative analysis methods: Dosimetric comparison: Paired t-tests (or non-parametric tests) were used to compare D98%, D2%, and Dmean for CTV and PTV. Plan complexity: Control points and the number of MUs were compared. Treatment

efficiency: Treatment times for the Halcyon and Infinity platforms were used to assess treatment efficiency, with differences analyzed using independent sample t-tests. Statistical software: Statistical analysis was conducted using R or SPSS. Results were presented as mean ± standard deviation, with statistical significance set at $p < 0.05$.

6 Reproducibility of the Protocol Any other researcher can recreate the VMAT plans for NSCLC cases on the Halcyon and Infinity platforms using the same treatment plan parameters (such as dose limits, target definitions, and OAR limits). Researchers may contact the authors for more detailed information on the RayStation 9A treatment plan configuration files and optimizer parameters.

7 Contributions of the Protocol This protocol quantifies the differences in dosimetric performance and treatment efficiency of Halcyon and Infinity platforms in NSCLC radiotherapy. By providing standardized experimental procedures and detailed dosimetric analysis, this study facilitates comparative research on the two platforms in subsequent multi-center studies.

Protocol references

[1]. RaySearch Laboratories. RayStation 9A Documentation. [Available at: https://www.raysearchlabs.com/]
[2]. Ettinger DS, Wood DE, Aisner DL, Akerley W, Bauman JR, Bharat A, et~al. NCCN Guidelines® Insights: Non–Small Cell Lung Cancer, Version 2.2023: Featured Updates to the NCCN Guidelines. Journal of the National Comprehensive Cancer Network. 2023;21.
[3]. Bradley JD, Paulus R, Komaki R, Masters G, Blumenschein G, Schild S, et~al. Standard-dose versus high-dose conformal radiotherapy with concurrent and consolidation carboplatin plus paclitaxel with or without cetuximab for patients with stage IIIA or IIIB non-small-cell lung cancer (RTOG 0617): A randomised, two-by-two factorial phase 3 study. The Lancet Oncology. 2015;16.